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Rogers - Ship Building Made Easy. 1865

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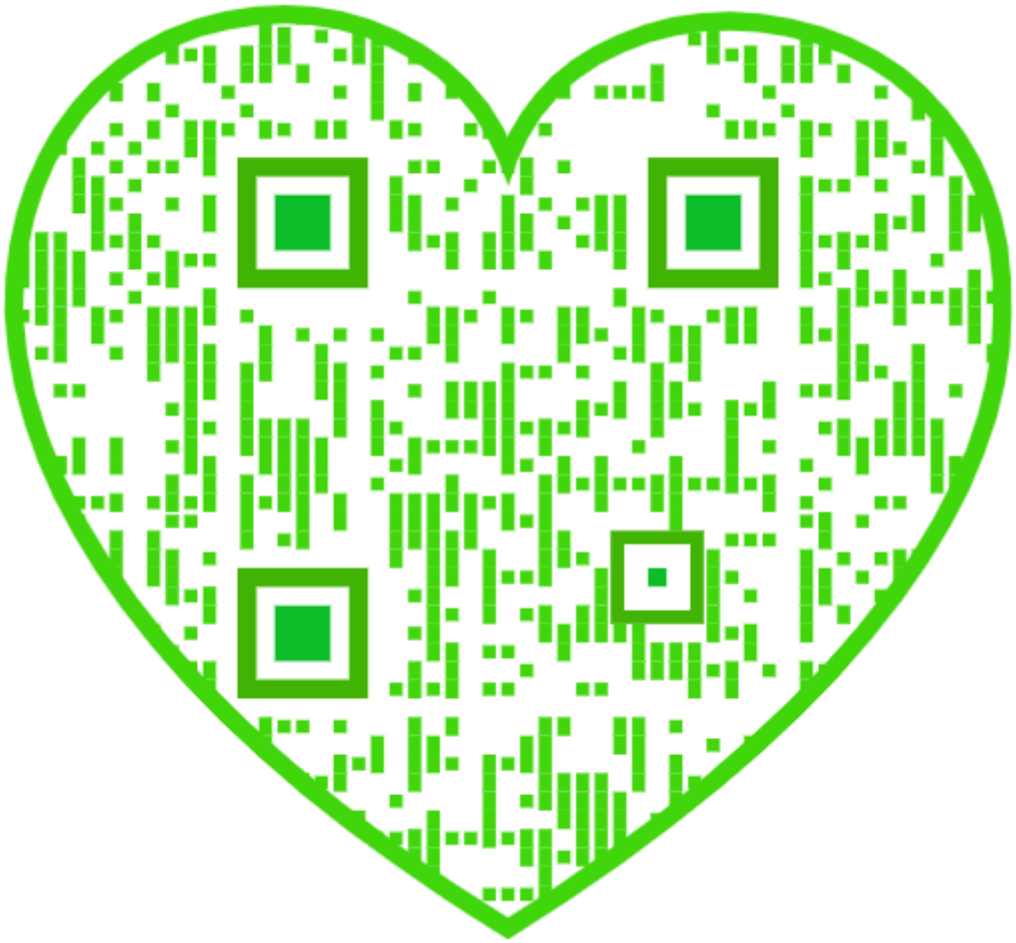

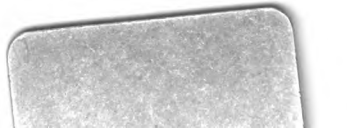

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SHIP BUILDING MADE EASY;

BY G. W. ROGERS,

ACT'G VOL. LIEUT. U. S. N.

ST. LOUIS:

R. P. STUDLEY & CO., PRINTERS, COR. MAIN AND OLIVE STREETS.

1865.

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PREFACE.

In publishing this, my second work on Ship Building, I have endeavored to simplify as much as possible the difficult parts. The work will be short, as I am explaining the plainer rules of ship draughting only, and have no doubt but by the time the new beginner is through with this little book, he will understand enough of draughting to enable him to manage the lines of a vessel in the mould loft, either by a model or otherwise.

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SHIP BUILDING MADE EASY.

CHAPTER I.

To commence the study of ship draughting, it is necessary to understand something of the simple parts of geometry, such as points, lines, angles, superfices, solids, &c. A point is position without magnitude; the commencement or termination of a line is a point, or where two or more lines cross each other.

A line is length without breadth or thickness. A line may be drawn from any given point to another given point. Either a curved or straight line, or two lines may be drawn at equal distances from each other, called parallel lines, and continued on for an indefinite length, as long as the equal distance is preserved; but as soon as the distance between them is either increased or diminished, they cease to be parallel lines, as they must necessarily cross each other when the distance is diminished, or diverge from each other when the distance is increased.

A circle is a plain figure, contained by one line called a circumference, which line is at equal distances in every part from a certain point within the circumference, called the centre. A line drawn from the

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centre to the circumference is called the radius. (A, Fig. 1.) A line drawn through the centre, each way to the circumference, cuts the figure in two equal parts, called semicircle. This line is called the diameter of the circle. (B, Fig. 1.) A line drawn on either side of the centre, cutting the figure in two unequal parts, is called the chord. (C, Fig. 1.) An arc of a circle is any part of the circumference, as (D, E, F, Fig. 1.) A segment is an arc and its chord, as (D, C, F, E, D, Fig. 1.) A versed line is a line drawn from the middle of the chord at right angles till it reaches the circumference, as (C, E, Fig. 1.) A sector of a circle is that part of the area of a circle contained by an arc and two radii, as (G, H, I, Fig. 1.)

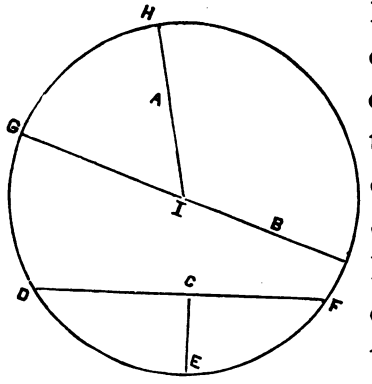

Fig. 1.

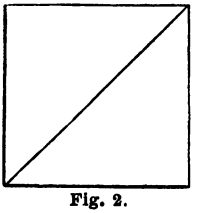
Fig. 2.

A square is a plain figure with all its sides equal, and all its angles right angles, as (Fig. 2.) A line drawn from one of its points diagonally to the other, cuts the figure in two equal parts, and is called the diameter of the square.

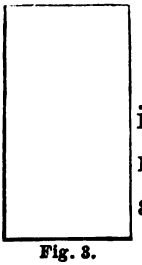
Fig. 3.

A rectangle is a four sided figure with all its angles right angles, but all its sides are not equal. It is also called parallelogram, as (Fig. 3.)

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A parallelogram, whose sides are equal, but angles are not right angles, is called a rhombus, as (Fig. 4.)

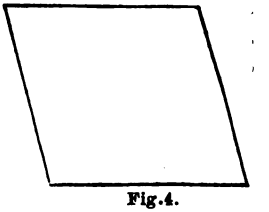

Fig. 4.

Also, one whose sides are not equal, and whose angles are not right angles, is called a rhomboid, as (Fig. 5.)

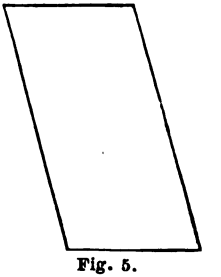

Fig. 5.

A plain figure has length and breadth, as Fig. 5, till by giving it also depth, as in Fig. 6 it becomes a solid; thus we see a line has only one property, viz: length; a plain figure two, viz: length and breadth; a solid three, viz: length, breadth and thickness.

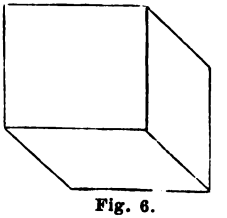

Fig. 6.

Fig. 7 is a right angle, or two sides of a square.

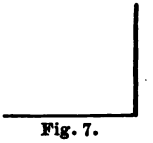

Fig. 7.

Fig. 8 is an obtuse angle, because it is greater than a right angle.

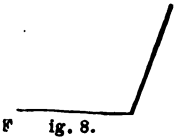

Fig. 8.

Fig. 9 is an acute angle, because it is less than a right angle.

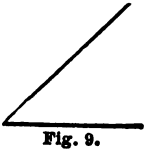

Fig. 9.

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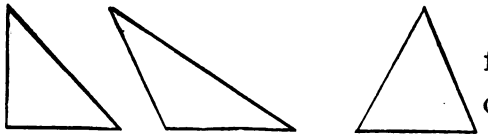

Fig. 10.

If you draw a line from the extreme end of the base to the top of the perpendicular, called the hypothenuse, they will become triangles, as Fig. 10.

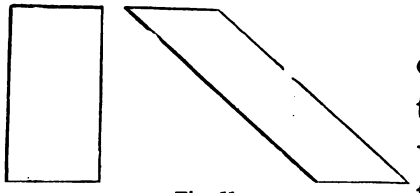

Fig. 11.

Four sided figures, with equal bases and equal altitudes, do not change in value of area by altering their angles. Fig. 11.

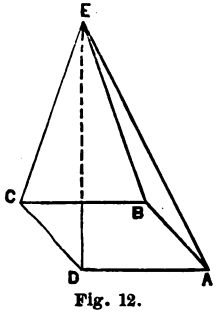

Fig. 12.

Fig. 12 is a solid figure, called a pyramid, A, B, C, D, being the base, and E the apex. The solid contents are obtained by taking the size in the middle, and the length, and proceed as in measuring square timber.

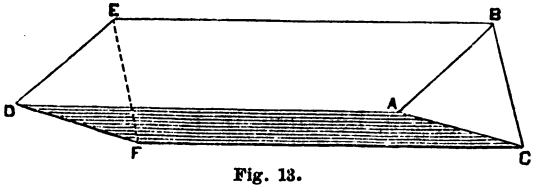

Fig. 13.

Fig. 13 is a prism. A, B, C is the right hand end, and D, E, F is the left hand end; D, A, C, F is the bottom; D, E, B, A is the top; and F, E, B, C is the back. The solid contents may be obtained by measuring the end half way between A B and A C, and proceed as in Fig. 12.

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Fig. 14 shows how to divide a given angle in two equal parts. From the point C, as a centre, at any distance describe the arc of a circle A B, and from A and B as centres, describe the arcs of a circle, crossing each other at D. A line drawn from the point C through D will divide the angle as required.

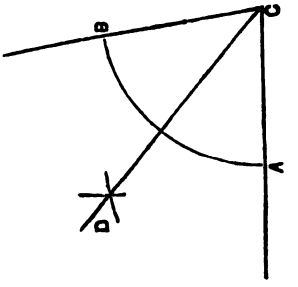

Fig. 14.

Fig. 15 shows how to erect a perpendicular from a base line. From the point B as a centre, describe the arcs of a circle, A and C; then from A and C as centres, at any distance greater than A B or C B, describe the arcs of a circle crossing each other at D, then draw the line from B to D, which is what was required.

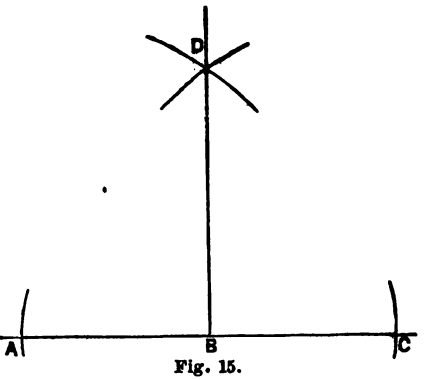

Fig. 15.

Or again, figure 16, from the point A, at any distance above the line as a centre, describe the arc B C D, cutting the base at B and C; draw a line from B through the centre, A, and continue it till it cut the arc at D. The line which joins C and D is the perpendicular required.

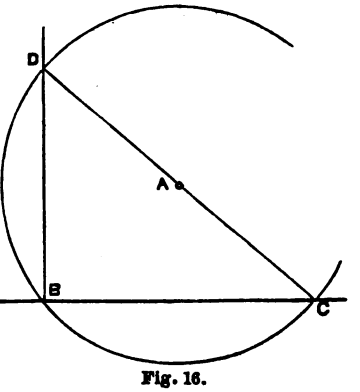

Fig. 16.

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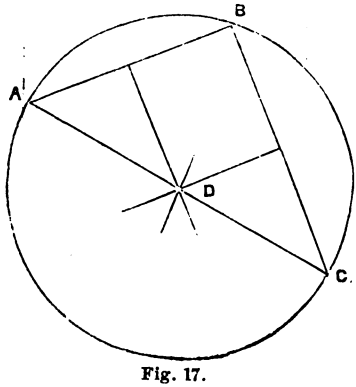

Fig. 17.

Fig. 17 shows how to draw a circle through any three given points. Let A, B, C be the given points; draw a line from A to B, divide it, and draw a line from the middle and at right angles to it; next draw lines from C to B, and from A to C, proceed as in the first line, and where the lines cross at D as a centre, describe the circle A, B, C.

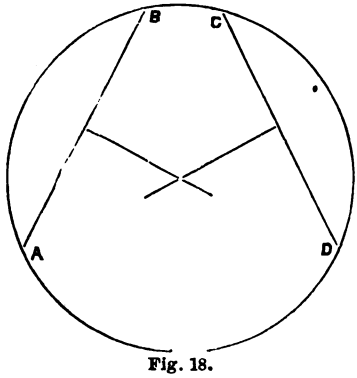

Fig. 18.

Fig. 18 shows how to find the centre of a circle by a part or the whole of a circumference. Draw two lines at any part of the figure, as at A B and C D, divide them and draw lines at right angles from the middle, and where those two lines cross will be the centre of the circle.

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CHAPTER II.

I shall now proceed with an explanation of Plate No. 1, which is a diagonal line drawing of a vessel, whose forward and after rabbet lines are arcs of a circle; also, the front of the stem, the forward and after harpings at the half width lines in the half width plan; the cross sections or frames in the body plan, and the diagonal lines fore and aft; all are arcs of a circle, and the water lines, if any are drawn on this plate, will be the same. The reason of this I will explain before proceeding further, viz.: The model of the vessel is turned on a lathes with both ends turned off so as to form one half of a sphere or ball of the same diameter of the width amidships. When it comes from the lathe it is sawed through the middle, fore and aft, and forms two model, of the kind and description you are now at work upon. I will commence with the supposition that you have made yourself perfectly familiar with the simple rules laid down in the preceding chapter. The first line to be drawn is the one marked base, (Plate 1.) This line is the top of the keel as it lays on the blocks. You will next draw a line of the depth of the vessel, above and parallel to the base. This is called the top height. These lines constitute what is called the shear plan. (Fig. 1.) The next to be drawn is a line parallel with

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the base, at any convenient distance above the top height. This is called the centre line. After which draw a line above the centre at one half the width of the vessel, and parallel to the base. This is called the harping, or half width line. The two last lines constitute what is called the half width plan. (Fig. 2.) You now may set off your frames from the line marked with the dead flat sign in the centre of the drawing, each way towards the bow and stern at any distance you wish. You will perceive I have not commenced at the centre, but have only drawn eight frames at each end, which is owing to the peculiar shape of the model. You may now begin with the curved lines, at the point O, which is the commencement of the widest part of the vessel, on the top of frame 2, taking it as the centre, and at the distance of the depth of the vessel describe the arc C, B, D. Next set off the size of the head of your stem on the top height line at E; then set off the depth of the keel below the base line, and draw the bottom of the keel, which is the line 1, 2; and from the point 2 and E, as centres, at the distance O, C, describe the arcs crossing at A; and the point A, as the centre, with the distance O, C, describe the arc 2, 3, 4, E. This line forms the front of the stem. Draw the after rabbet line in the same way. After which set off the size of the stern-post, and draw the perpendicular line F, which is the back of the stern-post. You may now draw the side lines, G and H, forward and aft, which lines are the side lines of the stem and stern, at the one half their

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thickness from the centre. You are now ready to draw your forward and after harping on the half width plan; and, judging by what I have already explained, I have no doubt you are aware of the fact, that the shear plan, between the forward and after rabbet lines, is in every respect of the same form and dimensions of the half width plan. The very form of the model renders any other shape impossible. You will, therefore, at the point O, on the half width plan as a centre, and at the distance O, C, or the half width of the vessel, describe the arcs J and K. You are now ready to draw the body plan. First draw the side lines (Fig. 3) at half the thickness of the stem and stern, and parallel to the perpendicular line marked dead flat, one on each side; take the distances from the base line to the points where the perpendiculars 1, 2, 3, 4, 5, 6, 7, 8 cut the rabbet lines at the bow and stern, and transfer the same distances from the base to the side lines, (Fig. 3;) after which you will take the width from the centre line, (Fig. 2,) at the lines 1, 2, 3, 4, 5, 6, 7, 8, and transfer them to the top height line, (Fig. 3,) each way from the centre O, and from the point O, as the centre, describe the arcs 1, 2, 3, 4, 5, 6, 7, 8 on the body plan, (Fig. 3.) These are the frames of the bow and stern of the vessel. The midship frames are all of the same shape of the frame marked 1, 2, on the body plan. You will now run in your diagonals, and must exercise your judgment in placing them in the body plan. They are the points for beveling the timbers, and also for cutting them off

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and framing them together. I have run in four diagonals on the body plan, and will proceed to explain the manner of transferring them to the half width plan. I will commence with the third diagonal on the forward body. From the point where the third diagonals meet at L, to where the one on the forward body cuts the arc numbered 1 and 2, which is also the midship frame, take the distance with your dividers and transfer it to the half width plan; from the centre outward on the frames marked dead flat and 2, draw the line M; then take the distance from the point L to the base line at O, and transfer to the rabbet line of the stem at N, on the shear plan; next take the distance from the point N forward to the perpendicular line that bounds the drawing; and transfer it to the side line of the stem (Fig. 2) at P, and from the point P and R as centres, with the distance O, C, describe the arcs crossing at S; and with the point S for a centre, with the distance O, C, describe the arc P, R, which is the true curve of the third diagonal line in the forward body. You may transfer all of the diagonal lines from the body plan (Fig. 3) to the half width plan (Fig. 2) in the same manner.

And I shall here leave you to finish this drawing, as it will exercise you and prepare the way for the next plate, which will contain a plain diagonal line draught of a vessel, the curved lines of which are *not* arcs of a circle. And although the drawing is of the same nature of the one preceding it, yet it will be a great deal more difficult of construction.

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CHAPTER III.

PLATE II.

Draw your base, top height, centre and half width lines as in the preceding plate; also the side lines, fore and aft, on the half width plan. (Fig. 2.) Next draw the rabbet line of the stem, of a curve to suit your fancy, in the fore body, (Fig. 1,) and the rabbet line aft. (Fig. 1.) Next draw your shear line, (Fig. 1,) fore and aft, giving one, two or three feet shear, or as much or little as may be required. You will then draw the perpendicular lines A at half the width of the vessel from the midship frame of the shear plan. (Fig. 1.) These are the half width lines of the body plan. (Fig. 3.) The midship frame (Fig. 1) forms the centre line of the body plan. (Fig. 3.) You may set off the side lines B at the same distance from the centre of Fig. 3 that the same lines are from the centre line of Fig. 2 at the bow and stern of the vessel. You will next draw the curved lines on Fig. 3 that are marked with the midship sign. This will give you the shape of the midship frame, or the shape of the vessel amidships. The next thing to be done is to draw the diagonal lines on the body plan. (Fig. 3.) I have drawn four, both in the forward and after body. They are straight lines on the body plan, but when transferred to the half

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width plan they will be curved lines, and will vary more or less as the vessel is made full or sharp at the bow and stern. We will commence with the second diagonal line as follows: You will set one leg of your dividers at the point where the second diagonal cuts the midship frame, and take the distance to the centre line on a level or parallel with the base, and transfer this distance to the half width plan, or No. 2, at the midship frame, at the point C. Next take the distance from the base (Fig. 3) to where the second diagonal cuts the side line, and transfer it to the rabbet line of the stem at the point D; then take the distance from the perpendicular line at the stem head to the point D, and transfer it to the side line, (Fig. 2,) and draw the perpendicular line from the centre to the side line marked E. You will now draw the curved line in pencil from the point C, on the midship frame, to the line E, at a suitable distance from the side line to allow for the thickness of the plank. This distance is obtained as follows: Set your dividers at the distance of the thickness of the plank forward of the line E on the side line, and describe the arc of a circle F, and in running your line let it touch the arc F. You will now take the distances from the centre to this line at the frames E, K, M and O, and transfer the same to Fig. 3 on the second diagonal line, and on a level with the base, and from the centre line. You will then take the distances from the base, (Fig. 1,) at the above named frames, and to where the said frames cut the rabbet line of the stem,

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and transfer them to the side line, (Fig. 3,) and draw lines parallel with the base from the centre to the side line at the heel of the frames M and O. You now have two points on the body plan for the frames E, K, M and O, viz: At the second diagonal line, and at the heel. To procure another, you must proceed as follows: Take the distance from the base to the shear line, (Fig. 1,) at the frame E, K, M and O, and transfer said distances to Fig. 3, at the half width and side lines, and draw the dotted lines you will perceive on the body plan; then take the distances at the above named frames from the centre line (Fig. 2) to the half width line, and transfer them to the body plan from the centre outward on the dotted lines, and draw the curved line G. You will now perceive that there are three points to each of the above named four frames, which you will now proceed to draw, as nigh correct as your eye and your judgment will admit of; and if you have a good eye and sufficient judgment, you will, in nine cases out of ten, be all correct, so far as the second diagonal is concerned on Figures 2 and 3. And to bring the frames all correct at the other diagonals, you must take the distances of the frames (Fig. 3) at the first diagonal, and transfer them to Fig. 2, and if you have the frames on Fig. 3 correct, the line will be fair on Fig. 2; if not, you must alter the shape of your timbers until the line is fair. The manner of obtaining the third and fourth diagonals is the same, as also the frames of the after body. After which you will mark all your lines in ink, and rub out

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your pencil lines. The next thing to be done is to lay down the cants, which is done as follows: About one inch forward of the forward whole frame, which frame is the one that is bolted against the deadwood, (and on the present drawing is the frame marked K,) draw the line marked H, which is the after side of the forward cant, to the point on the half width line where the next frame intersects it, and on the present drawing is marked L; then set set your dividers the distance of the thickness you intend your cant to be, and draw a line parallel to the line H, which line is the forward edge of your cant. You will now proceed to set off the heads of your cants on the half width line, at the distance H, M, the heels one inch apart in the clear, the moulding edge of the cant from the forward edge of the one preceding it. The present drawing has five cants and a knighthead, twelve inches wide on a square from the side line. You are now ready for your bearding line, which line is the landing place for your cants, and is procured in the following manner: At the side line B, (Fig. 3,) take the distances from the base to where the diagonal lines cut the side lines, and transfer them to Fig. 1, and draw the lines marked 1, 2, 3, 4; then take the distance where the frames M and O cut the side line, (Fig. 3,) and transfer them to the frames M and O on Fig. 1, setting up from the base line. You may now draw the bearding line through those seven points, which line is the upper edge of the rabbet of the stem, cut the distance obtained from Fig. 2 at the

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landings of the diagonal lines, and from Fig. 3 at the heels of the square frames at their landings on the side line. The perpendicular lines on top of the bearding line, (Fig. 1,) are the places where the knighthead and cants and are bolted to the deadwood, and are obtained by taking the distance from the point J, where the harping intersects the side line, (Fig. 2,) to the points where the cants intersect the side line at their heels, and the knighthead and forward edge of the forward cant join at the side line. Transfer these distances to Fig. 1 at the bearding line, and draw the perpendiculars above named You are now ready to procure the shape of the cants, and as all cants are alike, we will take cant No. 4 from the diagonals. Commencing at the head, take the distance from the point K, where the moulding edge of the fourth cant cuts the half width line, (Fig 2,) and transfer it to Fig. 1, at the point L; then from the point L down to the base transfer it to the body plan, (Fig. 3,) and draw the line M. You will next take the distance (Fig. 2) from the point where the fourth cant cuts the side line to the point K, where the fourth cant cuts the harping line, transfer the same to Fig. 3 from the side line on the line M; and from the points where the four diagonals cut the fourth cant, take the distance parallel with the square frames and transfer them to Fig. 3, diagonal lines, and draw the lines 1, 2, 3, 4, parallel with the base. You now have the perspective view of the cant on the diagonal lines, (Fig. 3;) and to procure the correct shape of the timber you must take

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the distance from the point where cant 4 cuts the side line, (Fig. 2,) to where the same timber cuts the four diagonal lines, on a range with the cant of the timbers, and transfer the same distances to Fig. 3, from the side line to the respective level lines marked 1, 2, 3, 4. You now have the points at the head of the timber and at the four diagonals, yet still lack the point at the heel where it lands on the side line at the bearding. This you can procure by taking the height (Fig. 1) from the base to the bearding line at the perpendicular line marked 4, transferring the same to Fig. 3, then draw the curved line marked cant 4, on the body plan, (Fig. 3.) This plan of obtaining the cants from diagonal lines is fully as correct as taking them from the water lines, only it is rather more trouble, as you may perceive you have the width to take twice, once on the square and once on a range with the line of the cant. The fashion timber in the after body is obtained in the same way, it being nothing more or less than a cant. The transom in the after body is drawn by the eye. The seat on the stern-post, or rather the prick-post, never to be placed lower than the top height amidships. The bearding line aft is obtained the same as forward, by taking the distance from the rabbet, or line of the transom N, to the points where the diagonals cut the side line, (Fig. 2,) and transferring them to Fig. 1, at the respective heights of the diagonals; also taking the height of the frames at the side lines (Fig. 3) where they cut through it, and transfer the same to the corresponding frames,

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(Fig. 1,) and draw the bearding line as you see it in the present drawing, which is what is called a square diagonal line drawing, from the fact that all the widths are taken from Fig. 3, on a square or parallel with the base. There is another method of drawing diagonal lines, called expanded diagonals, by taking the distances from the point on Fig 3, where the diagonals meet at the centre line, and taking the widths of the frames on a range with the lines, which, when transferred to Fig. 2, will cause the diagonals to run outside of the half width lines, (at least some of them,) making the drawing look unnatural, and the lines out of place. I have built over one hundred vessels of different kinds, but have never had any use for an expanded diagonal.

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CHAPTER IV.

PLATE III.

The present drawing is taken from a model, and consists of water lines. It is obtained as follows:

Take six pieces of soft pine or other wood, and plane them up to one foot thick, according to the scale you are working on, and of half the width of your vessel. Also one piece of a sufficient thickness to work out your shear, and fasten them together as you see at Fig. 1. Work them to the required shape, making all your lines fair. After your model suits you, take your paper and draw a base line as at A, (Fig. 1.) Also a perpendicular or centre line amidships; and after having drawn a centre line on your model, lay it on its back on the paper, with the centre line of the model to the centre or perpendicular line on the paper, and mark all around it, which is the outline of Fig. 1. You will next draw the centre line B, (Fig. 2,) parallel to the base, and lay the model with the top to the paper and the back to the centre line, and mark all around it, which will be the outline of Fig. 2. You will now remove the upper section of the model, (which piece you are done with,) and lay the model at Fig. 2, with the centre of the model to the midship frame, and mark round it, which will be the sixth water line. Turn it on its back

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and lay it on the paper at No. 1, and draw the straight line along the top of the model marked No. 6. Remove another piece from the top, replace the model on No. 2, mark round it, which will be the fifth water line. Also draw the straight line on Fig. 1, marked 6. Repeat this process till all the pieces of the model are removed, when there will be six straight and one curved longitudinal lines on Fig. 1, with a curved line for the bow, and seven curved lines on Fig. 2. This process of obtaining the lines of a vessel is so simple, that any school boy should be able to master it; and yet it is the most perfect system in the world, and the one most generally in use. We will now make the necessary preparations for obtaining the shape of all the frames. The first thing to be done is to draw the perpendicular lines at the bow and stern, connecting the two figures. Also the frames on each side of the centre or midship frame. In the present drawing I make use of numbers fore and aft, there being seventeen square frames forward of midships, and fifteen aft. Like the preceding drawing, I have only made use of sufficient of the frames to enable me to draw the lines on No. 2, from the fact, that to draw all the timbers or frames in the body plan would only serve to perplex the learner instead of enabling him to see his way clear. We will now commence. And as there is no place on the paper of sufficient size to lay down the body plan, or No. 3, we will place it as in the preceding drawing, on top of the shear plan No. 1. You will set your dividers at

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the point on the centre line, (Fig. 2,) where it is connected with the midship frame, and take the distance on a range with the frame to where it intersects the half width line, and transfer the distance to No. 1, on each side of the midship frame, (which serves as the centre line of the body plan, Fig. 3.) Draw perpendiculars at each of these points at B. You will then take the distance from the base to the shear line, (Fig. 1,) at the midship frame, and transfer it to the perpendiculars B, and draw the top height line C, (Fig. 3.) Next you will take the distances from the base to the shear, at the frames 5, 10, 13, 15, 17, and transfer them to the line B and side line D, and draw light pencil lines parallel to base. After which take the distances from the centre to the half width lines at the same frames, (Fig. 2,) and transfer them to their respective lines, (Fig. 3.) making the points at the heads of the above named five frames. Draw the curved line E, which will be the heads of all the frames in the fore body. The next thing will be the midship frame, which is procured by taking the distance (Fig. 2) from the centre to the first water line, and transferring it to the first water line, (Fig. 3;) then 2, 3, 4, 5 and 6 in the same manner, and draw the curved lines in the forward and after bodies, marked with the midship sign; then take the distances at the same five frames at all the lines from the centre, (Fig. 2,) and transfer them to their corresponding lines, (Fig. 3.) We now have all the points for these frames, except the heels which are obtained by taking the dis-

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tances from the base to the rabbet line at 15 and 17, and transfer them to the side line D, drawing lines from the side to the centre line, parallel to the base. The frames 5, 10 and 13 do not rise any on the side lines. You will now draw the curved lines through the points at the top height, diagonal lines, and heels, or landings on side lines, and you have the true shape of the frames corresponding to the figures of the same denomination in the half width plan, or Fig. 2. The balance of the frames are obtained in the same manner, with the exception of the top height, which is to be taken from Fig. 2 and transferred to Fig. 3, to the line E, without any reference to Fig. 1. You will procure the depth of the rabbet by setting your dividers to the thickness of the planking, and from the point at the landing of the timbers, whether on the keel or the rise of the rabbet line. You will set off the thickness of the plank below, and, using it for a centre, will describe the circle from the landing downward, as you see it on this drawing; and in running in your frames, let the batten rest on the above named arc of a circle. The square frames being all drawn, the cants may be laid down on Fig. 2, as described in the preceding chapter. The bearding line is procured by taking the distances from the perpendicular F, at Fig. 2, to where the six water lines cut the side line, and transferring them to Fig. 1, at corresponding lines. The depth of the rabbet is procured by the same means, at the ends of the water lines at Fig. 2, that were used at the heels of the square frames at Fig.

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3, as described above. Draw your bearding line (Fig. 1) through the points on the water lines, and through the points procured from the frames 10, 13, 15 and 17, (Fig. 3,) and transferred to corresponding frames at Fig. 1. After having your cants laid down on Fig. 2, and your bearding line down on Fig 1, the cants are transferred to Fig. 3. I have only taken off two, and will explain the process by taking off cant 5. Set your dividers at the point where this cant intersects the side line at the point G, and take the distance on a range with the cant to the first water line, (Fig. 2.) Set the same on the first water line, from the side line, (Fig. 3,) and from the same point (Fig. 2) take the distance to the second water line, and transfer to the second water line, (Fig. 3;) and from the same point (Fig. 2) take the distance to the third, fourth, fifth and sixth water lines, and transfer to corresponding lines on Fig. 3. You will now take the distance to the harping line, and transfer to Fig. 3, and draw a line perpendicular in pencil, so as to be afterwards rubbed off. And to obtain the height, you may take the distance parallel with the base to where the cant 5 cuts the harping, (Fig. 2,) and transfer to the shear line, (Fig. 1,) at the point H; transfer the distance from the point H down to the base line (Fig. 1) to Fig. 3, on the perpendicular just described, which will be the head of cant 5. It is but a short distance above the shear line of the square frames. You now have all the points for drawing your cant, except the heel, which is procured by taking the distance from

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the perpendicular F, (Fig. 2,) to where the fifth cant intersects the side line; transfer the same to Fig. 1 on the bearing line, and draw the perpendicular line, marked heel of cant 5, on Fig. 1; then take the distance from the base to where cant 5 cuts the bearding line, (Fig. 1,) and transfer the same to Fig. 3, on the side line, and draw the cant as it is on the present drawing. It will not be necessary to describe any of the others, as they are all obtained in the same manner. The perpendicular lines 1, 2, 3, 4 and 6 are obtained in the same manner you have already obtained No. 5, and are the lines that are to be made on the stem and deadwood for bolting on the cants. The heel of the knight-head is obtained by getting the point on the bearding line where the forward side of the forward cant cuts the side line, and transferring the same to the bearding line, (Fig. 1,) and from which draw the perpendicular, marked heel of knight-head. The mould for the knight-head is made to fit the bearding line, and cuts off at the heel at the above named line, with the water lines marked on it. Also the top height for the bevel spots in getting it out, the back or upper edge to be of a corresponding size to the size of your frames. You are now done with the forward body, and must turn to the after body. The first thing to be done, will be to lay down your transom, taking the width between the centre and the half width line, (Fig. 2,) and transferring it to the top height, (Fig. 3,) which height is procured by taking the distance from the base to the top of the shear, (Fig. 1,) and transferring it to Fig. 3. You may draw your transom by taking it from your

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model; or you may vary a little, if you deem it necessary. But in no case let the seat or breach of your transom come lower than your top height amidships. After having drawn your transom, proceed to get the height of the frames 5, 8, 11, 13 and 15, (Fig. 1,) and transfer them to Fig. 3, making lines parallel to the base. After which take the widths off Fig. 2 and transfer to Fig. 3 on corresponding lines, and draw the curved line H from the transom to the midship frame. Take the same method of procuring the frames, as in the forward body. You are now ready for your fashion timber, which is nothing more than a cant, only that it meets in the centre instead of cutting off at the side line. You will first determine on the thickness of your transom, and draw a line for the forward side. Then draw the after or moulding side of your fashion timber. You may run it as far forward at the heel as you may think it necessary, but in all cases you must let it cut away a part of the forward side of your transom, so as to have a chance to fasten it. You transfer it to Fig. 3 in the same manner you procure the shape of your forward cants. You can have as many small transoms as you like. I have drawn a stool and three small transoms in the present plate. The stool extends from the sternpost to the fashion timber, and sets on top of the deadwood, while the small transoms reach only from the fashion timber to the bearding line. I have made use of the water lines for the bottom of the stool and transoms; and to get the upper side of the same you must

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draw lines of the thickness of them above the water lines, (Fig. 3,) and let the lines extend over two or three of the square frames. Take the widths at Fig. 3 and transfer to Fig. 2, and draw the lines you see on Fig. 2, which I have shaded so as show the bevelings, the shaded part being the after edges when they are worked out. Where you see the stool and transoms on Fig. 1 is merely to show them in perspective, after they are up and in their places. This view is obtained by taking the distances at the water lines, (Fig. 2,) and transferring them to Fig. 1, and drawing the curved lines, which is the after side of the fashion timber. You can see here that the stool reaches from the stern-post to the timber, while the small transoms only reach the bearding lines. The deadwood reaches as high as the second water line. I have not drawn any cants in the after body, and you no doubt can see the necessity of throwing the heels of the frames, 14 and 15, forward out of the way of the fashion timber. If you wish to do so, it is done exactly as the fashion timber, only you take the widths from the side line the same as in the forward cants. I will now proceed to explain the manner of procurring the bevelings, and to do so, must draw diagonal lines as near where the frames are to be joined together as possible. I will, on the forward body, draw a diagonal where the head of the floor timber is supposed to join the top timber. This one line will be sufficient to make myself understood. The next thing will be to take the widths of all the frames from

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Fig. 2 and transfer them to Fig. 3. I have only marked in ink where the said frames cross the line at the floor head, and rubbed out the remainder, as I wish to have as few lines in the way as possible, for the purpose of showing in the plainest manner what I am endeavoring to explain to you. The first thing to be done is to procure a board of same width of the distance of the frames from centre to centre, draw a line across the top with a square, and from this line, on either edge of the board, mark the distances of each frame from the one preceeding it. You will procure the distances on a short batton. Commencing at dead flat, (Fig. 3,) you will take the distance from dead flat to 1, and from 1 to 2, and from 2 to 3, and so on to 12, which is the last square frame. Set these distances on either edge of your board as before described, above the line if you wish to bevel from the forward side of your frame, and below the line if you wish to bevel from the after side of your frame. You will draw lines from each of these points to the point on the opposite edge of your board where the square line commences. This plan of beveling is as near perfect as any I have ever seen. In taking the distances from Fig. 3, you must measure on a square from one line to the other. The bevelings of the cants and fashion timber are obtained by drawing a line on a square from the moulding side of the timber, at the point where it cuts the side line, to the forward side, as you see it done at Fig. 2; and from the points where the back of the timber meets this

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square line, you will take the widths at the different lines, and transfer them to Fig. 3, and take the distances between these lines at each cant, and it will be the exact bevel of the timber according to its thickness. Where the line is above the cant, it will bevel under so much in its thickness; and where the line is below or outside of the cant, the bevel will be standing that much in the thickness of the timber. The bevel of the heel is procured at Fig. 2, where the cants join the side line. The knight-head bevels may be procured at the water lines; or you may lay down the outer edge by transferring it to Fig. 1, and take the distance from the bearding line on a square to the outer line, and it will be the bevel of the knight-head. The bevel of the fashion timber is procured the same as the cants. The bevel of the small transoms from the fashion timber at Fig. 3, or the distance of the shaded parts on a square, (Fig. 2,) is what they will bevel in their thickness. The main transom can be beveled from the diagonal lines and the top height. But the best method is to run in two or three buttock lines, which will be fully explained in the next chapter.

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CHAPTER V.

PLATE IV.

The object of the present drawing is to show that a line may be drawn, either a curved or straight line, on the shear plan, the half width plan, or body plan, and transferred to the other two, showing the correct shape of the line in *all*. Thus, if a line be straight on the shear plan, it will be curved on the half width and body plan, and *visa versa*. We will commence the explanations by taking the preceding drawing, without the cants or fashion timbers, &c., leaving only the water lines on Figs. 1 and 2, and the square frames on Fig. 3. We will commence at the line on the shear plan, marked No. 1. It is an inclined line, starting at the heel of the 16th square frame, and cuts the upper part of the bow of the vessel off, as far back as the head of the top timber at frame No. 7. We will suppose this upper part to be removed, and the object now is to show the shape the opening will present if we were to take a bird's eye view of Fig. 2; and also the shape the same opening will present if we were to stand forward and look aft. It is obtained by taking the distances from the perpendicular line marked A, to the points where the straight line No. 1 cuts the water lines, (Fig. 1,) and transferring them to Fig. 2; measuring from the

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same line A, on the corresponding water lines, making points where the measurements cut the lines, the forward end lands in the rabbet at the end of the second water line. Draw the curved line No. 1 through these points, (Fig. 2,) and you have the perspective view of the opening. For the view at Fig. 3, you will take distances from the centre line (Fig. 2) to where the curved line, No. 1 cut the water lines, and transfer the same to Fig. 3, on corresponding lines. The upper end lands on the harping, at frame No. 7; the lower end in the rabbet at the second water line. Draw the curved line No. 1, at Fig. 3, through these points, and you will have what was required. The straight line No. 2, (Fig. 1,) is obtained in the same manner. We will now proceed to the straight line No. 3, on the half width plan. It runs direct from the side line at the heel of frame 14, and lands on the end of the top timber at frame 7, cutting off the starboard bow of the vessel. We will suppose the piece so cut off to be removed, and to show the shape it would present at Fig 1 if we were to stand along side and look at the vessel. You will take the distances from the line A to where the oblique section line No. 3 cuts through the water lines, and transfer them to Fig. 1. Measuring from the same line, making points where the measurements cut the corresponding lines, (Fig. 1,) the heel of the line ends at the side line at the bearding of the stem, while the head lands at the top at frame No. 7. You may draw the curved line No. 3 through the above described points at Fig. 1, and you

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will have the correct shape or appearance the vessel would present with this piece cut off. To find the shape at Fig. 3, you will take the width from the centre (Fig. 2) to where the straight line No. 3 cuts the water lines, and transfer the same to Fig. 3, at corresponding lines, the heel landing at the 14th frame, and the head at the harping line at frame 7. Draw the curved line No. 3, at Fig. 3, through these points, and you will have what was required. The straight line No. 4 is procured in the same manner. You will perceive it is curved on Figs. 1 and 3, and you will find by experimenting on this drawing, that there is no conceivable shape in which you can run a section through either of these figures, but what you may find a corresponding section on the other two. We have proved it in Figs. 1 and 2, and will now proceed to prove it in Fig. 3. We will take the straight line No. 5, at Fig. 3. You may perceive that it commences at the first water line, and ends at the side of the stem forward. You can procure the shape of it on Fig. 2, by taking the distances from the centre (Fig. 3) to where it cuts the water lines, and also the frames; and by taking the distances to corresponding lines at Fig. 2, you will produce the curved line marked No. 5, at Fig. 2. And by taking the distances from the line A at Fig. 2, to where the curved line No. 5 cuts the water lines, transferring the same to Fig. 1 on corresponding lines; also from the base, (Fig. 3,) to where the straight line No. 5 cuts the frames, transferring the same to the frames,

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Fig. 1, you will produce the curved line, No. 5, at Fig. 1. I have now fully explained the nature of section lines, so far as cutting off a part of a vessel with a straight line, and will now try a section of a different character. At the point where the centre line is intersected by frame 11, you will set your dividers to the distance of the point B, and with 11 as the centre describe the arc of a circle from 7 to 15. This arc, connected with the centre l'ne at 7 and 15, forms a semi-circle, or one-half of a well of that size, provided the vessel was built with one cut out of her. Now, it must be plain to all that this well could not be cut out of the centre of the vessel, in Fig. 2, without showing itself in the shear plan, if looked at when standing alongside of the vessel, and also in the body plan, when standing aft of the vessel and looking forward. We will first get the shape of the well at the shear plan, Fig. 1, by taking the distances from the line of the transom, C, to where the arc or edge of the well cuts the water lines at Fig. 2, and transfer them to Fig. 1, at the corresponding water lines, measuring from the rabbet line, D, making points as you see them enclosed by rings at Fig 1. You may also take the distances to where the buttock lines are cut at Fig. 2, and transfer them to Fig. 1 at the buttock lines; also transfer the landing of the ends of the arc, at the centre line, Fig 2, to the base line, Fig. 1, and draw the curved line that encloses the shaded part of the lower part of Fig. 1, and you have the exact appearance of the opening on Fig. that the well would present if you were to look at the

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vessel from alongside and opposite the well. The circular section cut out of Fig. 2 on the outside, extending from the frame 7 to 15, can be obtained in the same manner. The next move will be to obtain the shape the well would present, were we to stand at the stern and look forward. This can be done by taking the distances from the centre, Fig. 2, to where the well cuts the water lines, at the forward and after part of it, and transfer them to Fig. 3 on the corresponding lines. You will perceive that the well cuts each line at two places; the buttock lines are also cut in two places, and can be transferred from the shear plan, Fig. 1, to the corresponding lines at Fig. 3. You may also, if you wish, take the height at Fig. 1, where the well cuts the frames, and transfer them to Fig. 3, and draw the curved line enclosing the lower shaded part on Fig. 3. The outer circular section, Fig. 2, is obtained in the same way; and if you wish to carry the theory out still farther, you may describe a circle on any part of Fig. 1 or Fig. 3, and obtain a corresponding view of the circular space at the other two figures. Neither is it necessary to confine yourself to a circle. You may draw any shape or curve your fancy may dictate, on either of the three figures, and obtain the corresponding shape or appearance it would present at either or both of the remaining figures. Fig. 4 is the shape the counter would present if you were to stand on a level with it and look forward. Fig. 5 is the shape of the counter when standing under it and looking up at it. Fig. 6 is the shape of the counter as laid down

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on the floor ready for making the moulds, and is the same as at Fig. 5. Fig. 7 is the manner of showing the difference of the widths at Figs. 4 and 5. The manner of obtaining the shape of the counter is by running in as many buttock lines as will cover the counter. In the present drawing there are but three that cut it. Buttock lines are obtained in various ways. In my former work I have a drawing giving the shape of all the frames, but at the same time it would not be advisable to use them for that purpose. They are very useful in the stern of a vessel, to obtain the points of the frames after they cross the upper water line. They are also useful to prove water lines or diagonals, and in laying down the counter they are indispensable. The easiest way to get them is to draw perpendiculars at Fig. 3, at any distance, commencing at the centre. On the present drawing I have used the lines of the square frames. Number them as you see at Fig. 3, where I have run in six of them. You will also put lines at Fig. 2, commencing at the centre, and at the same distance from each other. And by measuring from the line of the transom, C, to where the buttock lines cut the water lines, and transferring the same distances from the rabbet line, D, on the corresponding lines, you will have the points where the buttock lines at Fig. 2 will cross the water lines at Fig. 1. The points where 4, 5, 6, land on the harpin line must be transferred to Fig. 1 at the shear line. The points where the buttock lines cross the rabbet line, Fig. 1, are obtained by measuring up from the base, Fig. 3, to where the buttock lines, 1,

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2, 3, 4, cross the line of the transom. The points where the buttock lines at Fig. 1 cross the lines of the frames, are obtained by taking the distances from the base to where the buttock lines cut the timbers at Fig. 3, and transferring them to Fig. 1. The points where the buttock lines at Fig. 1 cut the counter E, are obtained by taking the distances from the transom line C, at the buttock lines, 1, 2 and 3, to where the counter crosses those lines. The counter may be drawn in pencil till proved correct at Fig. 2 by running the buttock lines at Fig. 1. The counter line E starts at the head of the bearding line, F, at the head of the rabbet of the stern port; the upper end of the buttock lines, from the last frame to the counter line, are marked with a pencil till your counter and buttock lines agree, when you mark in ink, and rub out the pencil lines. The arc, G, is drawn by making the intersection of the counter line and stern rabbet the centre, and describing the arc G at the distance of the extremity of the counter, and gives you the true or expanded size of your counter, Fig. 6. Fig. 4 is obtained by taking the distances from the rabbet to the points of the line, E, that are cut by the buttock lines, taking the distances parallel with the base. This figure is of no material consequence, only to show the difference between the appearance of the counter on a square, as it is called, and the real shape and size of it as it must be built to go in the vessel.

The counter timber mould is made at Fig. 6 to fit the line H, from the centre to the top height, and cuts off at the transom line.

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The bevel of the heel is obtained at Fig. 7, that of the top height at the harping, and the intermediate bevels at the buttock lines at Fig. 1.

I believe I have said all that is necessary in the explanation of this drawing, and know of nothing necessary to add to it. I believe, however, that it will be necessary to describe the method of measuring a vessel by the builder's tonnage. I have built perhaps a hundred, and have always taken the length of the keel from the rabbet of the stern post to the commencement of the rise of the rabbet of the stem, and the width of the frame in the widest part, and the depth from the top of the floor timber to the top of the beam, multiply the length by the width, and the product by the depth, and that product you will divide by ninety-five, which gives you the number of tons you are to charge for in building.

I might add quite a number of tables for calculating the weight and size of materials, measurement of lumber, &c., but consider it quite out of place, if I even had the time to spare to do it.

I am requested by my friends to publish a small work on draughting, so simple that it may be understood by the most ordinary capacity. I have endeavored to do so, and believe I have succeeded, at least I think I have. If I am mistaken I shall be the only sufferer, as I shall be the only loser. Hoping you may all be as well satisfied with it as I am, I most respectfully leave it to your consideration.

St. Louis, March 22, 1865.

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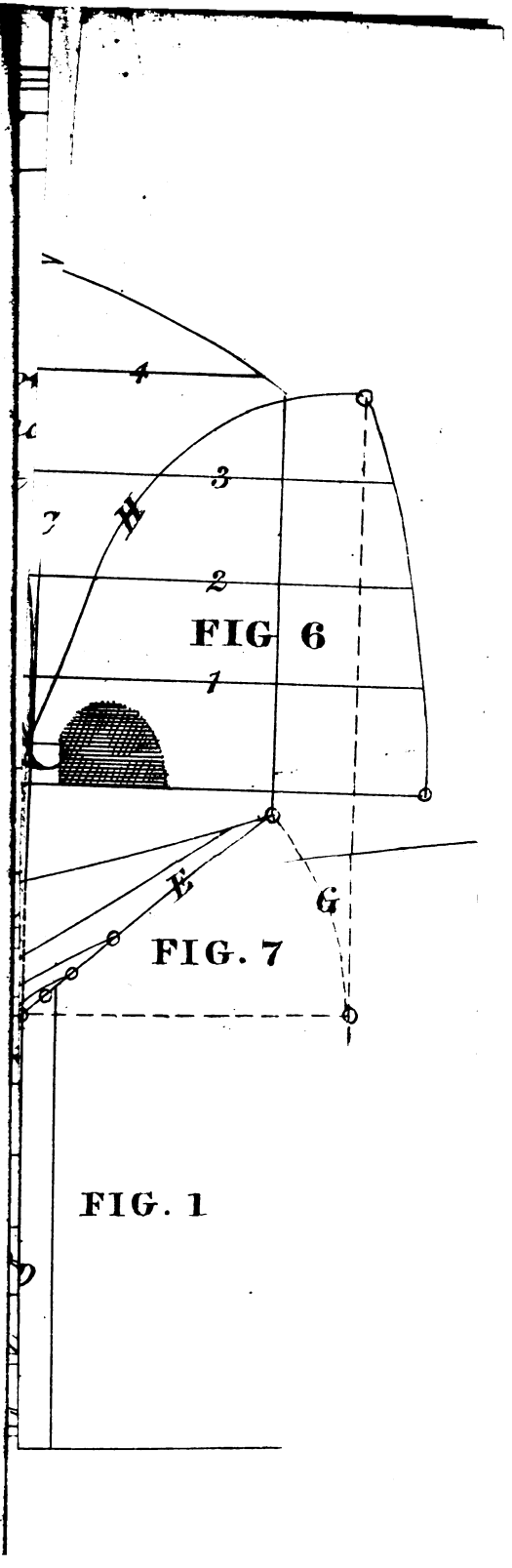

FIG 6

FIG. 7

FIG. 1

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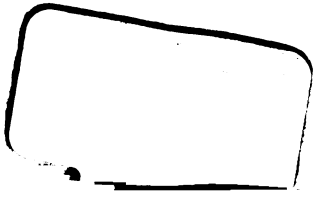

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